

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
)
Revision of Part 15 of the Commission’s Rules) ET Docket No. 07-113
Regarding Operation in the 57-64 GHz Band) RM-11104
)

REPORT AND ORDER

Adopted: August 9, 2013

Released: August 9, 2013

By the Commission: Acting Chairwoman Clyburn and Commissioners Rosenworcel and Pai issuing separate statements.

I. INTRODUCTION

1. By this action, the Commission modifies Part 15 of its rules for intentional radiators operating on an unlicensed basis in the 57-64 GHz frequency range (60 GHz). As discussed in detail below, we are modifying our rules to: 1) allow higher emission limits for 60 GHz devices that operate outdoors with very high gain antennas to encourage broader deployment of point-to-point broadband systems; 2) specify the emission limit for all 60 GHz devices as an EIRP power level to promote repeatability of measurement data and provide uniformity and consistency in the rules; and 3) eliminate the requirement for certain 60 GHz devices to transmit identification information (transmitter ID). The amended rules will allow longer communication distances for unlicensed 60 GHz point-to-point systems that operate outdoors and thereby extend the ability of such systems to provide broadband service, particularly to office buildings and other commercial facilities. We believe that the enhanced 60 GHz systems that will be allowed by these rule changes will help the Commission fulfill its objectives to bring broadband access to every American by providing additional competition in the broadband market, lowering costs for small business owners accessing broadband services, and supporting the deployment of 4th generation (4G) and other wireless services in densely populated areas.¹

II. BACKGROUND

2. The 60 GHz band is part of the spectrum often termed the “millimeter wave” bands.² The propagation range of millimeter wave radio signals, and in particular signals at frequencies around 60 GHz, is much more limited than that of radio signals at lower frequencies, as the higher frequency signals are significantly affected by the presence of oxygen and water vapor within the atmosphere.³

¹ In 2009, Congress directed the Commission to develop a National Broadband Plan to ensure every American has “access to broadband capability.” See American Recovery and Reinvestment Act of 2009, Pub. L No. 111-5, 123 Stat. 115 (2009); see also, *A National Broadband Plan for Our Future* in GN Docket No. 09-51, *Report and Order*, 26 FCC Red. 11819 (2011).

² The term “millimeter wave” is taken from the fact that the wavelength of radio signals for frequencies between 30 GHz and 300 GHz ranges from 10 millimeters down to 1 millimeter. Wavelength, λ , in meters, is calculated by the formula $\lambda = C / F$, where C is the speed of light (i.e., 3×10^8 meter/second) and F is the frequency in Hertz.

³ See *Attenuation by Atmospheric Gases*, International Telecommunications Union, *Reports of the CCIR*, 1990, Vol. V, Report 719-3, at p. 189. See also *OET Bulletin 70, Millimeter Wave Propagation: Spectrum Management*

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Absorption and scattering caused by oxygen and water vapor at frequencies around 60 GHz limit the useful range of transmissions to a couple of kilometers.⁴ In 1995, the Commission determined that these attenuating factors, which limit the potential for interference, make the 60 GHz band particularly suited for general unlicensed devices.⁵

3. The 60 GHz band is allocated on a co-primary basis to the Federal Mobile, Fixed, Inter-Satellite and Radiolocation services; and to non-Federal Fixed, Mobile and Radiolocation services.⁶ Currently there are very few licensed Federal and non-Federal services operating in the 60 GHz band. Under Part 18 of the rules, industrial, scientific and medical (ISM) equipment may also operate in the 60 GHz band at 61.25 GHz \pm 250 MHz.⁷

4. Part 15 of the Commission's regulations permits the operation of radio frequency (RF) devices without an individual license from the Commission or the need for frequency coordination.⁸ The technical standards contained in Part 15 are designed to ensure that there is a low probability that such devices will cause harmful interference to other users of the radio spectrum.⁹ Unlicensed operation within the 60 GHz band is permitted under Section 15.255 of the rules.¹⁰ Any type of unlicensed operation within the 60 GHz band is permitted under these rules, with the exception of operation onboard aircraft or a satellite. Except for fixed field disturbance sensors,¹¹ the rules limit the average power density of any emission in this band to 9 μ W/cm² and the peak power density to 18 μ W/cm², measured at a distance of 3 meters from the radiating structure.¹² These average and peak power density limits are equivalent to average and peak EIRP limits of 10 W (40 dBm) and 20 W (43 dBm), respectively.¹³ The rules also limit

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Implications, July 1997, at

http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet70/oet70.pdf.

⁴ *OET Bulletin 70, Millimeter Wave Propagation: Spectrum Management Implications, July 1997, at* http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet70/oet70.pdf, at p. 7.

⁵ *Amendment of Parts 2, 15 and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications, First Report and Order and Second Notice of Proposed Rule Making, ET Docket No. 94-124 (First R&O/Second NPRM in ET Docket No. 94-124), 11 FCC Rcd. 4481, 4496 (1995) at para. 33.*

⁶ 47 C.F.R. § 2.106.

⁷ 47 C.F.R. §§ 2.106 note 5.138, 18.111 *et seq.*

⁸ 47 C.F.R. §§ 15.1 *et seq.*

⁹ The primary operating conditions under Part 15 are that the operator of a Part 15 device must accept whatever interference is received and must correct whatever harmful interference is caused. Should harmful interference occur, the operator is required to immediately correct the interference problem, even if correction of the problem requires ceasing operation of the Part 15 equipment causing interference. *See* 47 C.F.R. § 15.5.

¹⁰ 47 C.F.R. § 15.255; *see First R&O/Second NPRM in ET Docket No. 94-124, 11 FCC Rcd. 4481 (1995).*

¹¹ Fixed field disturbance sensors are required to comply with a lower emission limit across the 60 GHz band except between 61.0 GHz and 61.5 GHz. 47 C.F.R. § 15.255(b)(2) & (b)(3). *See also, Amendment of Parts 2, 15 and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications, Memorandum Opinion and Order and Fourth Notice of Proposed Rule Making, ET Docket No. 94-124 (MO&O/Fourth NPRM in ET Docket No. 94-124), 12 FCC Rcd. 12212, 12215 (1997) at para.11.*

¹² *See* 47 C.F.R. § 15.255(b).

¹³ Power density (P_D), EIRP and field strength (E) are readily converted through the following formulae: $P_D = E^2/120(\pi) = \text{EIRP}/(4 \pi D^2)$, where D is the separation distance in meters, provided measurements are performed in the far field.

the peak transmitter conducted output power of 60 GHz unlicensed devices to 500 mW.¹⁴ For emissions from 60 GHz devices that emanate from inside a building, the rules also require the transmission of an identification signal in order to permit other users experiencing interference from indoor wireless local area network (LAN) devices to more accurately identify the source of the interference.¹⁵

5. In the 60 GHz band, two primary types of equipment serving different markets have emerged to share this large 7-gigahertz swath of spectrum: 1) outdoor short-range point-to-point systems intended to extend the reach of fiber optic networks by providing service to adjacent structures, provide broadband backhaul links between cellular networks base stations, or interconnect buildings in campus environments;¹⁶ and 2) in-building wireless personal area networking (WPAN) devices designed to share, usually within the same room, uncompressed high-definition (HD) data signals between consumer entertainment devices, such as high-definition televisions (HDTV), Blu-ray digital video recorders,¹⁷ cameras, and laptop computers.¹⁸ Typically, an outdoor point-to-point 60 GHz transmitter employs a high gain, narrow beamwidth antenna that is aligned with the intended receiver, whereas a low-power indoor 60 GHz networking transmitter uses a lower gain and broader beamwidth antenna to serve several receivers within the network.¹⁹ In general, a low-power indoor networking transmitter uses an integrated antenna, *i.e.*, the antenna is part of the device and cannot be replaced with another antenna type without making significant physical alterations to the device, possibly rendering it inoperative. In addition, the transmitter output port of these devices is typically not accessible. With respect to outdoor point-to-point 60 GHz transmitters, practical concerns regarding the impact of significant propagation losses at these frequencies require the transmitter to be very close to the antenna (*i.e.*, both the antenna and transmitter will generally have to be located outdoors).

6. The Commission adopted the *Notice of Proposed Rulemaking (NPRM)*²⁰ in this proceeding in response to a petition for rule making from the Wireless Communications Association (WCA).²¹ To encourage broader deployment of point-to-point digital systems in the 60 GHz band without increasing the potential for harmful interference, the Commission proposed to specify the emission limit for 60 GHz devices as EIRP instead of as power density units, and to increase the emission limit from 40 dBm to 82 dBm for devices using an antenna with gain greater than 51 dBi. The Commission also proposed to increase the peak power and average power EIRP limits relative to a specific antenna gain for devices located outdoors or those located indoors with emissions directed

¹⁴ The 500 mW peak transmitter output limit applies to transmitters with an emission bandwidth of at least 100 MHz and is reduced for systems that employ narrower bandwidths. *See* 47 C.F.R. § 15.255(e).

¹⁵ *See* 47 C.F.R. § 15.255(i).

¹⁶ *See, e.g.*, BridgeWave E60 product line, FCC ID No. RWM-GE60X; Huber and Suhner model SL60-401, FCC ID No. TTDSL60401; Comotech Airlight (ME-100) series, FCC ID No. RL3ALME100.

¹⁷ Blu-ray refers to an optical disk format that enables recording, rewriting and playback of high-definition video as well as storing large amounts of data. The format offers more than five times the storage capacity of traditional digital video discs (DVD) and can hold up to 25GB on a single-layer disc and 50GB on a dual-layer disc.

¹⁸ *See, e.g.*, Abocom Wireless HD transmitter radio module, FCC ID No. MQ4-VM101T01; Murata Wireless HD radio module, FCC ID No. XCSSUX-1278; Panasonic Wireless HDMI system, FCC ID No. ACJ-TUWHT1U.

¹⁹ “Beamwidth” refers to the angle between the half-power points (*i.e.*, the -3 dB points) of the main lobe of an antenna, when referenced to the peak effective radiated power of the main lobe. Beamwidth is usually expressed in degrees. Point-to-point 60 GHz devices typically have a beamwidth of less than 5 degrees.

²⁰ *See* Revision of the Commission’s Rules Regarding Operation in the 57-64 GHz Band, ET Docket No. 07-113, Notice of Proposed Rulemaking, 22 FCC Rcd. 10505 (2007) (*NPRM*).

²¹ *See* Petition for Rule Making submitted by WCA, RM-11104.

outdoors, *e.g.*, through a window,²² and to eliminate the transmitter identification requirement for devices located indoors.²³ The Commission did not propose to make any change to the spurious emission limit but proposed to also express this limit alternatively as EIRP to be consistent with the measurement unit proposed for main-beam fundamental emissions.²⁴

7. Seven parties filed comments and three parties filed replies in response to the *NPRM*, addressing both outdoor and indoor uses in the 60 GHz band.²⁵ Outdoor equipment providers unanimously supported the Commission's proposals to express the emission limits in EIRP levels, to increase the average and peak emission limits for transmitters with very high gain antennas, and to eliminate the transmitter ID requirement for all 60 GHz transmitters.²⁶ Some commenters from the indoor networking providers recommended that we wait until standards for WPAN consumer devices are finalized so that we can take those devices into consideration before deciding whether to allow higher power for 60 GHz point-to-point outdoor devices.²⁷ We note here that many of the WPAN industry standards have been adopted since the release of the *NPRM*. For example, ECMA International has adopted a standard for 60 GHz WPAN for data transfer and multimedia streaming such as high definition audio visual streaming and wireless docking stations.²⁸ The WiGiG Alliance has finalized its 60 GHz specification that will support connectivity with Wi-Fi networks,²⁹ and the WirelessHD Consortium has released a global standard for 60 GHz applications based on the IEEE 802.15.3c-2009 standard to support lossless video streaming in low-power devices such as smart phones and laptop computers.³⁰

III. DISCUSSION

8. In this Report and Order, we modify our rules to allow operation at higher power levels by 60 GHz unlicensed devices that use an antenna exceeding a specific gain and operate outdoors. Specifically, for 60 GHz devices located outdoors, we increase the average equivalent isotropically radiated power (EIRP) limit from 40 dBm to 82 dBm minus 2 dB for every dB that the antenna gain is below 51 dBi, and peak EIRP emission limit from 43 dBm to 85 dBm minus 2 dB for every dB that the

²² WCA also requested that the Commission eliminate the transmitter identification requirement for 60 GHz devices that are located indoors but direct their emissions through a window to the outside. *See NPRM*, 22 FCC Rcd. 10505, 10507 (2007) at para. 5.

²³ *NPRM*, 22 FCC Rcd. 10505, 10511 (2007) at para. 14.

²⁴ *Id.*, 22 FCC Rcd. 10505, 10519 (2007) at Appendix B.

²⁵ A list of commenting parties is included in Appendix B.

²⁶ *See e.g.*, comments of BridgeWave Communications, Inc. (BridgeWave).

²⁷ Comments of Cisco Systems, Inc. (Cisco); *see also, ex parte* comments of Panasonic of North America Corporation (Panasonic) filed on Feb. 27, 2008.

²⁸ *See ECMA-387, High Rate 60 GHz PHY, MAC and HDMI PAL*, at <http://www.ecma-international.org/>. ECMA adopted a second edition of this standard in 2010.

²⁹ *See* <http://wirelessgigabitalliance.org/>. *See also* Wi-Fi Alliance and Wireless Gigabit Alliance to unify, Jan. 3, 2013, at <http://www.prnewswire.com/news-releases/wi-fi-alliance-and-wireless-gigabit-alliance-to-unify-185526012.html>. Wi-Fi refers to a class of wireless local area network ("WLAN") devices based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards that are installed in many personal computers, video game consoles, printers and other peripherals and virtually all laptop or palm-sized computers. Because 60 GHz signals are significantly attenuated by walls, it is expected that 60 GHz high-speed networks would most likely be limited to communication between devices located inside a single room. *See, e.g.*, <http://www.dailywireless.org/2013/01/03/wigig-folded-into-wi-fi-at-60-ghz/>.

³⁰ *See* <http://www.wirelesshd.org/>. *See also* IEEE 802.15.3c-2009 *Wireless MAC and PHY specifications for High Rate WPANs* standard; and IEEE 802.11ad-2012, *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput*.

antenna gain is below 51 dBi. Also, the amended rules will specify the emission limits for all 60 GHz devices in terms of equivalent isotropically radiated power (EIRP). These rule changes will provide needed flexibility to improve performance and provide cost savings for unlicensed devices to support broadband service in the 60 GHz band. These revisions also have the potential to foster the development of products with longer operating distances than are achievable under the current rules and to promote use of the 60 GHz band as a vehicle for broadband transmission links. This will encourage the development of very high speed wireless links for use in locations where highways, parking lots, or other obstructions may prevent the extension of fiber or wireline connections, to connect multiple buildings in a campus environment, or to provide backhaul connections for new 4G wireless services.

9. We also amend the rules to specify the antenna requirements for compliance testing of 60 GHz devices that will operate at higher power with very high gain antennas and to eliminate the transmitter identification (transmitter ID) requirement.

A. Power Limits

10. Section 15.255(b)(1) of the rules currently specifies an average power density limit of $9 \mu\text{W}/\text{cm}^2$ and a peak power density limit of $18 \mu\text{W}/\text{cm}^2$ for devices operating in the 60 GHz band, as measured at a distance of 3 meters from the radiating structure.³¹ As specified above, these limits correspond to a 40 dBm EIRP and 43dBm EIRP, respectively.³² In the *NPRM*, the Commission proposed to amend the rules to specify emission limits for all unlicensed 60 GHz devices in terms of EIRP. The Commission noted that there can be substantial difficulty in obtaining accurate power density measurements in the near field³³ for very high gain antennas when the far-field distance is much greater than the 3-meter distance at which the emission limit is specified.³⁴ The Commission observed that the distance to the point where an antenna's far field begins is variable depending on the size and configuration of the transmitting antenna,³⁵ whereas EIRP is easily calculated as the antenna conducted input power times the antenna gain, thus simplifying the determination of radiated emissions by eliminating the need to consider antenna near-field and far-field measurement issues, particularly where relatively large diameter antennas are employed.³⁶ The Commission also proposed to maintain the

³¹ See 47 C.F.R. § 15.255(b) and (e). These limits apply to equipment other than fixed field disturbance sensors.

³² 47 C.F.R. § 15.255(b)(1). Power density (P_D) may be converted to EIRP or field strength (E) through the following formulae: $P_D = E^2/120(\text{Pi}) = \text{EIRP}/(4 \text{ Pi } D^2)$, where D is the separation distance in meters, provided measurements are performed in the far field.

³³ Because the near field of an antenna is the region in which the electric and magnetic fields do not have a substantially plane-wave character but vary considerably with different distances from the transmitter, measurements results made in this region can vary substantially with varying distances from the transmitter. It is therefore possible to obtain test data that show a lower signal level than what would be measured at a greater distance, because emissions in the near field do not behave in as predictable a fashion as in the far field. In reality, the transition from near field to far field is not sharp, and the boundary line between these regions differs depending on the size of the antenna, the radiating wavelength, the desired accuracy of the antenna, and the extent of measurement errors that can be tolerated based on various applications, etc. See discussion on near field and far field regions of an antenna in *OET Bulletin 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01*, p 27-30, at http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf.

³⁴ *NPRM*, 22 FCC Rcd. 10505, 10511 (2007) at paras. 14-15. See also, 47 C.F.R. § 15.255(b)(1).

³⁵ The Commission indicated that the far field for an antenna with a diameter of 1.22 meter starts at 178 meters, which is considerably greater than the measurement distance of 3 meters specified in the rules. *Id.*

³⁶ *NPRM*, 22 FCC Rcd. 10505, 10511 (2007), at para. 14. For example, the far-field region of a dish-type antenna is conventionally considered to start at $2D^2/\lambda$, where D is the diameter of the antenna in meter and λ is the radiation wavelength in meters. The far field for a 32-centimeter 60 GHz dish antenna starts at 41 meters, whereas the far field for a 12-centimeter 60 GHz dish antenna starts at 5.8 meters. For these antenna types and sizes, the existing

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existing power density limits for devices other than very high gain systems as an alternative to the EIRP limits, as long as the 3-meter measurement distance is in the antenna far field. It observed that some parties may still wish to demonstrate compliance of devices with lower gain antennas under the existing power density limits and measurement procedures.³⁷

11. The current average power density limits for 60 GHz devices apply to all such devices, regardless of whether the device's antenna is located outdoors or indoors. In the *NPRM*, the Commission proposed to increase the average EIRP limit for 60 GHz devices with antennas located outdoors from 40 dBm to 82 dBm minus 2 dB for every dB that the antenna gain is below 51 dBi, and the peak EIRP limit from 43 dBm to 85 dBm minus 2 dB for every dB that the antenna gain is below 51 dBi.³⁸ It also proposed to apply these higher EIRP limits to devices with antennas located indoors with emissions directed outdoors (*i.e.*, window links) because all equipment within a room is usually under the control of the same user, who would be responsible for frequency management issues that may arise.³⁹

12. *Decision.* We are modifying the rules to specify the emission limits for 60 GHz devices in terms of EIRP. No party objected or provided any substantive comments to our proposals. We observe that the WCA petitioned for this change because the existing rules specify the emission limit at a measurement distance of 3 meters, a distance that would, as noted above, be in the near field of a high gain 60 GHz antenna, and measurements in this region of the antenna are difficult to make due to the high variability of the RF field.⁴⁰ Consequently, when this measurement distance is in the near field of a 60 GHz antenna, the test results can vary substantially with varying distances from the transmitter, making it very difficult to demonstrate compliance of the equipment under test with the emission limit due to lack of repeatability of the test results. We find that specifying the emission limits for 60 GHz devices as EIRP, which can be easily calculated, will simplify the process for demonstrating compliance with the rules.⁴¹ We further note that in other sections of the Part 15 rules, *e.g.*, the spread spectrum rules in Section 15.247 and the Unlicensed National Information Infrastructure (UNII) rules in Section 15.407, the emission limit for those devices is specified in terms of EIRP.⁴² Although in the *NPRM* we proposed to maintain the existing power density limits for devices other than very high gain systems as an alternative to the EIRP limits as long as the 3-meter measurement distance is in the antenna far field, we find that specifying the emission limit for all 60 GHz devices as EIRP will provide uniformity and consistency in the rules for all 60 GHz devices, simplify the measurement procedure, and improve the repeatability of test results. Measurement procedures that have been found to be acceptable to the

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rules specifying the emission limit at 3 meters would place this measurement distance in the near field of the antenna, a problem that partly prompted WCA to file its petition for rulemaking in this proceeding.

³⁷ *NPRM*, 22 FCC Rcd. 10505, 10511 (2007), at para. 15.

³⁸ *NPRM*, 22 FCC Rcd. 10505, 10509 (2007) at para. 8. These numbers were requested by WCA in its petition for rule making. See WCA petition for rulemaking, RM-11104. See also, BridgeWave *ex parte* comments filed Dec. 2, 2011.

³⁹ A "window link" refers to a 60 GHz transmitter installed indoors that is communicating with a corresponding 60 GHz receiver in a nearby building. Each "link" is a point-to-point connection, *i.e.*, between a single transmitter and a single receiver. *NPRM*, 22 FCC Rcd. 10505, 10513 (2007) at para. 19.

⁴⁰ See WCA petition for rulemaking, RM-11104.

⁴¹ A conducted emission measurement is made by direct connection of a calibrated test instrument to the transmitter's output port of the equipment under test. See 47 C.F.R. §§ 15.303(f) & 15.403(n).

⁴² The reason why not all emission limits in Part 15 are specified in EIRP is because it is not feasible in some unlicensed intentional radiators to have access to the transmitter output port to perform a conducted power measurement (whereas for licensed transmitters, conducted power measurement in EIRP is the norm.) In such cases, a radiated emission measurement in the antenna far field must be performed.

Commission in accordance with Section 2.947 of our rules may be used to demonstrate compliance.⁴³

13. Accordingly, we are amending Section 15.255(b)(1) of the rules to specify emission limits for all unlicensed 60 GHz devices in terms of EIRP. Because 60 GHz devices are already required to be tested for compliance, this rule change does not increase the burden on compliance testing for manufacturers and could facilitate the measurement of emission levels for both point-to-point and networking 60 GHz devices while greatly improving measurement accuracy.⁴⁴

14. As we discuss in detail below, although the record provides some support for the proposals made in the *NPRM* to increase the average and peak emission limits for transmitters with very high gain antennas, some commenters have expressed concern over the potential for window links using higher power levels indoors to interfere with the operation and deployment of WPAN and other consumer devices. We thus are modifying the rules to allow increased power for 60 GHz transmitters using very high gain antennas located outdoors, but we will not apply these higher limits to any antenna located indoors, including window links.

1. Indoor Devices, including Window Links

15. *Comments and Replies.* Several commenters oppose the proposal to allow higher EIRP limits for 60 GHz devices with antennas located indoors, including window links that would direct transmissions outdoors. Some of these commenters are concerned that such operations would increase the likelihood of interference to lower power WPAN and other consumer products, hampering the development of this new market. For example, the Institute of Electrical and Electronics Engineers (IEEE) 802.18 Radio Technical Advisory Group (IEEE RR-TAG) recommends that we take co-existence with low-power devices into consideration with regard to the proposed EIRP limits for systems using high-gain antennas. It states that there is a large consumer market for WPAN applications that exploit newer low-cost semiconductor technologies with envisioned short-range indoor products at low power.⁴⁵ IEEE RR-TAG recommends that we maintain the existing emission limits for 60 GHz devices operating indoors as window links, *i.e.*, continue to limit these devices to a maximum EIRP of 40 dBm average, and 43 dBm peak.

16. Motorola Inc. (Motorola) shares the same concerns as IEEE RR-TAG that point-to-point devices operating at the higher EIRP levels might interfere with indoor WPAN devices, especially in window links. Motorola points out that while in most circumstances the user/operator has control of the operating environment, in certain deployment scenarios (*e.g.*, shopping malls, airports, etc.) this may not be the case, because the user/operator of a high-power point-to-point 60 GHz device operating as a window link may not own the low-power WPAN networking devices operating nearby. Motorola believes that in such environments, improperly installed window links could create reflections that interfere with portable user devices. It states that, for example, if the window link is improperly deployed and the antenna is not orthogonal to the glass, reflectivity of 50 percent for incident angles greater than

⁴³ 47 C.F.R. § 2.947. The Commission's Laboratory will issue guidance for compliance measurements of millimeter-wave devices, including the 60 GHz devices. We further note that ANSI-accredited Standard Committee C63 is working on draft C63.10 American National Standard Procedures for Compliance Testing of Unlicensed Wireless Devices that provides guidance for testing millimeter-wave devices using both radiated and conducted measurement methods.

⁴⁴ Manufacturers of 60 GHz devices with integrated antennas, such as low-power indoor devices, may continue to choose a radiated emission method to show compliance. Other Part 15 devices use integrated antennas, and when a radiated emission measurement is performed on such devices and the rule specifies the limit as EIRP, the measurement result must be converted into EIRP to assess compliance. *See, e.g.*, 47 C.F.R. §§ 15.250(d) and 15.407(b). *See also*, footnote 13, *supra*.

⁴⁵ IEEE RR-TAG comments at p. 3. *See also* Panasonic comments at 2; Cisco comments at p. 3.

30 degrees can be expected which results in reflected signals that could overpower low power devices in near proximity.⁴⁶ Cisco Systems, Inc. (Cisco) argues that we should consider the likely uses of the band before modifying the rules as requested by WCA. It states that WCA presented its proposals as alternatives to DSL/cable modem platforms, which would suggest the use of transceivers in the windows of residential households, but the Commission focused on commercial (outdoor), not residential, use in the *NPRM*.⁴⁷

17. *Decision.* We will continue to require that all 60 GHz devices using indoor antennas, including those with emissions directed outdoors as window links, comply with the existing lower emission limits. We note that our rules already permit the use of 60 GHz point-to-point transmitters with a relatively low-gain antenna (*i.e.*, up to 30 dBi at the 10W (40 dBm) maximum EIRP, with a transmitter output power of 10 dBm) as window links, and they are now co-located with WPAN devices without causing harmful interference. In most cases, both types of devices are under the control of the same party who could take steps to eliminate interference, *e.g.*, by moving one or both devices a short distance away from one another. However, we agree with Motorola that in public locations such as shopping malls or airports, where a 60 GHz point-to-point device and a WPAN network may not be under the same ownership or otherwise control, the use of higher-power EIRP for window links may present concerns and difficulties in resolving potential interference among different equipment operators. We further observe that BridgeWave, a manufacturer of point-to-point 60 GHz devices, has submitted that window links are very rare because office building occupants rarely tolerate indoor mounting of a radio behind a window.⁴⁸ We thus conclude that window links may not generally be needed (or used) to link one building to another, but if they are used, they must continue to comply with the lower emission limit permitted under the current rules. Alternatively, operators can link one building to another by using higher power point-to-point outdoor installations (*e.g.*, from rooftop to rooftop). In addition, we do not expect that higher power 60 GHz transmitters using very high gain antennas would be a common candidate for residential installation destined to replace digital subscriber line (DSL) and cable modem broadband services, because the high cost of the point-to-point devices would preclude their off-the-shelf retail marketing to consumers.⁴⁹ Therefore, out of abundance of caution and in view of the limited use of window links as reflected in the record, we will not permit window links to operate at the higher EIRP levels.

2. Outdoor Devices

18. *Comments and Replies.* Commenters generally support the Commission's proposals to increase the average and peak emission limits for transmitters with very high gain antennas. In statements supporting the proposed rule changes, BridgeWave Communications, Inc. (BridgeWave) states that the proposed rule changes provide an opportunity to unleash the 60 GHz band's potential as a vehicle for truly competitive, very high speed internet service and gigabit private network applications that can be offered to the public at highly economical price points.⁵⁰ WCA states that the adoption of the proposed rules would promote the Commission's objectives of furthering the availability of broadband connectivity

⁴⁶ Motorola reply comments at p. 3.

⁴⁷ Cisco comments at pp. 5-6.

⁴⁸ See BridgeWave *ex parte* comments filed April 9, 2010 at p. 2; BridgeWave *ex parte* comments filed Nov. 16, 2011 at p. 2.

⁴⁹ Each 60 GHz point-to-point link pair currently costs close to \$20,000, making it highly unlikely to be targeted for the off-the-shelf consumer market. See http://www.tessco.com/products/displayProductInfo.do?sku=467826&WT.mc_id=google_base; <http://www.cdw.com/shop/products/default.aspx?EDC=1143490>.

⁵⁰ BridgeWave comments at p. 5.

to all Americans.⁵¹

19. On the other hand, IEEE RR-TAG expresses concern that a remotely-mounted 60 GHz device, even *outdoors*, may inadvertently transmit radiation through the window of a room where a WPAN receiver may be operating, and that with the proposed higher power, an antenna of 40 dBi would allow an EIRP of 100 times greater than the present limits. It believes that this would render WPAN products inoperable, stating that an outdoor transmitter operating at the higher EIRP limits would only need to be about 200 meters away from its receiver to produce as much signal as the WPAN system itself.⁵² IEEE RR-TAG recommends that we require transmit power control (TPC) for devices operating with high gain antennas and proposes that we require 1) transmitters operating outdoors at EIRP levels greater than 40 dBm average/43 dBm peak to implement TPC to limit the maximum power at the receiver end of the link to a level no more than 30 dB above the receiver noise floor; and 2) transmitters to be positioned in a manner that limits the power density at the perimeter of any nearby building to less than 9 $\mu\text{W}/\text{cm}^2$ (40 dBm EIRP), *i.e.*, the existing limit.⁵³

20. Other WPAN industry members echo IEEE RR-TAG's concerns. Motorola, which supports higher power for outdoor installations, endorses IEEE RR-TAG's recommendation for TPC in principle, but not the specific proposals suggested by IEEE RR-TAG. Absent more specific data and justification, Motorola recommends that we simply limit use to the minimum power necessary to complete the link in accordance with good engineering principles and require that all point-to-point devices have the ability to adjust power output downward.⁵⁴ Motorola does not support IEEE RR-TAG's recommendation for a power density requirement at nearby buildings' perimeter.⁵⁵ Panasonic Corporation of North America (Panasonic) states that interference may result where someone chooses to employ the full transmit EIRP proposed in the *NPRM* over a short distance in a dense office or multiple dwelling unit complex. It states that in such scenarios, a broadband signal 'beamed' into one unit using a high power link might leak into the receiver of an adjacent unit, whose resident might, for example, stream video using WirelessHD from a Blu-ray Disk Player or notebook computer to a television or video projector. Panasonic believes that such interference might be mitigated by requiring the high power link receiver to use a high gain antenna, permitting lower transmitter power for equivalent communication reliability, and by stipulating that the transmit power should be no higher than needed for link operation with power control at the transmitter.⁵⁶

21. In reply, both BridgeWave and WCA state that no party has submitted any technical studies or hard data to refute the Commission's belief that "the risk of interference from higher power, directional 60 GHz transmitters to lower power, omnidirectional systems will be minimal."⁵⁷ In supplemental comments, BridgeWave states that the proposed higher EIRP limit would allow 60 GHz transmitters to be used for backhaul in certain wireless 4G deployments. It asserts that the wireless broadband industry is experiencing an increased demand in densely populated areas for outdoor base stations, or "pico cells," serving 4G mobile devices in Worldwide Interoperability for Microwave Access (WiMax)⁵⁸ or Long Term Evolution (LTE) networks.⁵⁹ It submits that the distance between a pico cell

⁵¹ WCA comments at p. 2.

⁵² IEEE RR-TAG comments at para. 9.

⁵³ *Id.* at para. 10.

⁵⁴ Motorola reply comments at p. 4.

⁵⁵ *Id.* at footnote 9.

⁵⁶ Panasonic *ex parte* comments filed June 13, 2008 at p. 2.

⁵⁷ BridgeWave reply comments at p. 2 (quoting *NPRM* para. 9); WCA reply comments at p. 2.

⁵⁸ WiMax refers to interoperable implementations of the IEEE 802.16 wireless-networks standard (ratified by the WiMAX Forum), in similarity with Wi-Fi, which refers to interoperable implementations of the IEEE 802.11

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and a macro cell, or between two adjacent pico cells, is normally about 300-500 meters, and that traffic to and from mobile devices needs to be backhauled to the next pico cell or macro cell.⁶⁰ It argues that the combination of high capacity and the short distance between the cell sites makes the 60 GHz band an excellent backhaul solution for pico cells.⁶¹

22. Although not objecting to the proposals in the *NPRM*, licensed users of the 60 GHz band from the Space Frequency Coordination Group (SFCG) and the World Meteorological Organization (WMO) ask for more time to conduct research and express concerns related to the 57-59.3 GHz band where Earth Exploration Satellite Service (EESS) (passive) and Space Research Service (SRS) (passive) have a co-primary allocation. These parties state that this band is used for high-altitude advanced microwave sounding instruments (AMSUs) by several meteorological space agencies, including the National Oceanic and Atmospheric Administration (NOAA) in the United States, and that these measurements are an essential element in weather forecasts. Although the parties believe that the proposals for higher emissions may not impact EESS because of the relatively high atmospheric attenuation at these frequencies, they propose to conduct technical studies to determine the impact of our decisions.⁶² SFCG requests that we provide information about the density of millimeter wave transmitters per square kilometer in urban and rural areas, the RF characteristics of the transmitters around 60 GHz, and the maximum above-sea level at which these devices will be deployed so that it could perform studies to compute the value of the received power at the EESS satellite antenna derived from the aggregation of the transmitted devices within a pixel (satellite footprint) of an EESS satellite and to compare this received result with thresholds contained in ITU-R recommendations.⁶³

23. In reply, Motorola notes that the meteorological interests have not asserted that the proposed power modifications will surely result in interference to EESS, but that these parties ask for additional time to study the issue. Motorola believes that our proposals already protect these services because of the very high gain, pencil-thin antenna beams used.⁶⁴

24. *Decision.* Consistent with our proposals in the *NPRM*, we are modifying the rules to adopt an average EIRP limit of 82 dBm and a peak EIRP limit of 85 dBm, in each case minus 2 dB for every dB that the antenna gain is below 51 dBi, for 60 GHz devices using very high gain antennas that are located outdoors. We find that this increase in emission limits for antennas located outdoors will facilitate the use of longer range 60 GHz devices in wireless applications without causing harmful interference to authorized radio services in this band or disrupting the operations of other unlicensed devices, including indoor WPAN systems that currently use this band. We believe that this change in the rules will enhance the value of the 60 GHz band as a vehicle for delivering broadband, particularly the high-capacity backhaul required for 4G wireless services.⁶⁵ This approach will afford 4G and other

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Wireless LAN standard (ratified by the Wi-Fi Alliance). WiMAX is a broadband platform touted to have much more substantial backhaul bandwidth capacity than legacy cellular applications.

⁵⁹ LTE is the trademarked name of a high-performance air interface for cellular mobile telephony, and may be used for the next-generation mobile communications network.

⁶⁰ A pico cell is a wireless communication system typically covering a small physical area, whereas a macro cell is capable of covering a large physical area.

⁶¹ BridgeWave supplemental comments filed on April 9, 2010, at p. 3.

⁶² SFCG comments at p. 1-2.

⁶³ SFCG comments at p. 3, WMO comments at p. 2.

⁶⁴ Motorola reply comments at p. 5.

⁶⁵ BridgeWave *ex parte* comments filed Nov. 16, 2011 at p. 1.

broadband providers greater operational flexibility at lower cost by allowing them to use unlicensed devices for backhaul, reserving licensed spectrum for other uses, thereby promoting spectrum efficiency.⁶⁶ Because existing outdoor point-to-point 60 GHz devices are restricted to much lower emission limits, these changes to our rules would provide tangible benefits, including to small businesses and consumers, without additional regulatory costs.

25. In the *NPRM*, we tentatively concluded that several factors will offset any increase in the interference potential between equipment with very high gain antennas and other devices in the 60 GHz band. We noted that: 1) *the* very high gain antennas used would be highly directional, reducing the probability that a low power, omnidirectional system would be located within its beamwidth; 2) low power devices will operate primarily indoors because of their shorter range, whereas very high gain directional systems will primarily be located outdoors because of their longer transmission range, thus the emissions from directional systems, as seen by lower power indoor devices, will be attenuated significantly from intervening objects, such as building walls;⁶⁷ and 3) oxygen and water vapor absorption and scattering should further reduce ranges at which the radiated emissions from 60 GHz equipment with very high-gain antennas could cause interference.

26. We are not persuaded by the opposing commenters from the indoor networking industry that our preliminary view is incorrect. We find that the high propagation losses in the 60 GHz band combined with the pencil beam of the high-gain antennas substantially mitigate the interference potential of these devices. These devices must be very accurately pointed to a very precise location in order to operate effectively. As the antenna gain increases, the beamwidth of the antenna becomes narrower, making it less likely that these devices will cause interference to nearby receivers unless they are located directly in the path of this pencil-thin antenna beam.⁶⁸ In this regard, we observe that in order to keep a link with a high gain antenna operating, the transmitter and receiver must be aligned using a special alignment tool,⁶⁹ so that the likelihood of inadvertent transmission through such a window is remote. Because of the highly directional nature of 60 GHz point-to-point communications, if the link were misaligned and the transmitter's signals would be mistakenly directed toward a receiver other than its intended receiver, the communication link itself would be broken (transmission terminated) and realignment would be required to reestablish the link.

27. Additional factors further discount the likelihood of harmful interference, as suggested by IEEE RR-TAG, from an outdoor high-power remotely-mounted transmitter (*e.g.*, mounted on the roof of an adjacent building, on a balcony, or under a roof overhang) that may inadvertently transmit radiation into the window of a room where a WPAN receiver may be operating. One is the geographic separation between higher power point-to-point outdoor installations and low-power indoor WPAN networks. This factor is significant because of the very short range associated with 60 GHz devices (touted as a benefit by manufacturers of both outdoor and indoor consumer products in light of its security advantages). IEEE RR-TAG also fails to address the effects of attenuation. Even if a small portion of the emission from a high gain outdoor antenna were to enter into a room through a window, that low level emission

⁶⁶ *Id.*, at p. 2.

⁶⁷ While focusing on the outdoor market in the *NPRM*, we did observe that consumer applications for wireless interconnections in the 60 GHz band were forthcoming, and that because the 60 GHz devices that were being marketed at that time were intended for point-to-point outdoor use, there was no immediate risk of interference to 60 GHz unlicensed consumer devices. *NPRM*, 22 FCC Red. 10505, 10509 (2007) at para. 9.

⁶⁸ For example, some 60 GHz point-to-point products such as the Airlinx Communications GE60 series have an antenna beamwidth of 1.4 degrees with an antenna gain of 40 dBi, whereas the Airlinx Communications GE60X series has an antenna beamwidth of 0.6 degrees with an antenna gain of 46 dBi. See <http://www.airlinx.com/files/AIRLINX%20Bridgewave%2060GHz%20Data%20Sheet%200606.pdf>.

⁶⁹ See *e.g.*, how to align 60 GHz antennas at http://bridgewave.com/products/tech_overview.cfm.

would first be attenuated by the glass, before being further attenuated by other objects in the room, thus minimizing its potential interference effect significantly.⁷⁰ For all these reasons, and absent any record evidence to the contrary, it is our predictive judgment that the proposed change as limited to outdoor devices would not result in harmful interference, which is defined not to protect against isolated occurrences, but only against interference that “seriously degrades, obstructs, or repeatedly interrupts” a radio communication service.⁷¹

28. We also decline to adopt the IEEE RR-TAG’s recommendations for measuring nearby buildings’ perimeter power density and for adopting an automatic transmit power control to limit the maximum power at the receiver end of a point-to-point link. We find such requirements unnecessary for co-existence between indoor and outdoor unlicensed devices in this band because of the high signal propagation losses at these frequencies⁷² and the highly narrow beamwidth of the outdoor devices, as we discussed above,⁷³ furthermore, the IEEE RR-TAG did not support its recommendations with any specific interference data, as noted by BridgeWave and WCA.⁷⁴ As mentioned above,⁷⁵ in response to IEEE RR-TAG comments, Motorola recommends that, absent more specific data and justification, we simply limit use to the minimum power necessary to complete the link in accordance with good engineering principles and require that all point-to-point devices have the ability to adjust power output downward.⁷⁶ We agree with Motorola that we should not require the IEEE-recommended limitations without more data and justification.⁷⁷ However, we find that the power at an individual location can be adjusted by antenna selection⁷⁸, therefore it is not necessary to require that the ability to adjust power output be built into the transmitter, which would add cost without countervailing benefit.⁷⁹ We also note that both the 60 GHz outdoor and indoor equipment are unlicensed devices that do not have priority rights to the spectrum over one another; however, as we discussed above, the geographical separation of the two

⁷⁰ Some researchers indicate that at 60 GHz regular glass provides 11 dB/centimeter attenuation and mesh glass, 32 dB/centimeter. See e.g., C. Anderson and T. Rappaport, *In-building Wideband Partition Loss Measurements at 2.5 and 60 GHz*, IEEE Trans. Wireless Communications, vol. 3, no. 3, pp. 922–928 (2004.) Some researchers indicate that at 60 GHz, drywall provides 2.4 dB/centimeter attenuation and office whiteboard, 5 dB/centimeter. See e.g., Smulders, P.F.M., *60 GHz Radio: Prospects and Future Directions*, Proceedings Symposium IEEE Benelux Chapter on Communications and Vehicular Technology, 2003, Eindhoven, Table II at p. 5.

⁷¹ 47 C.F.R. § 2.1(c).

⁷² See footnote 78, *infra*. IEEE did not take into account any wall and window attenuations from buildings or structures that separate indoor 60 GHz WPAN networks and any potential outdoor 60 GHz device that may or may not be operating outside the building in which the WPAN network is located.

⁷³ Even if an outdoor 60 GHz transmitter were accidentally directed into the general area of a 60 GHz indoor networking equipment instead of directed toward its associated receiver (and discounting the very high attenuation characteristics of intervening windows and walls), it is doubtful that the indoor network equipment would be in the main beam of the outdoor transmitter.

⁷⁴ BridgeWave reply comments at p. 2, WCA reply comments at p. 2.

⁷⁵ See para. 20, *supra*.

⁷⁶ Motorola reply comments at p. 4.

⁷⁷ Motorola reply comments at p. 4.

⁷⁸ The total amount of transmit power is a combination of transmitter output and antenna gain. Note that the transmitter output limit for 60 GHz devices is not being changed and is kept at 500 mW. 47 C.F.R. § 15.255(e).

⁷⁹ We also note that 47 C.F.R. § 15.15(a) &(c) already state that all devices operating under Part 15 “shall be constructed in accordance with good engineering design and manufacturing practice,” that “[e]missions . . . shall be suppressed as much as practicable,” and that “the parties responsible for equipment compliance are encouraged to employ the minimum field strength necessary for communications and to provide greater attenuation of unwanted emissions than required by the regulations.”

types of equipment will eliminate any potential of harmful interference.

29. Finally, we observe that since the adoption of the *NPRM*, there has been ample time for SFCG to conduct its studies regarding the EESS. Further, the Commission does not maintain the specific data on 60 GHz devices as requested by SFCG, other than the information submitted in the device certification applications, which can be accessed through our public equipment authorization database.⁸⁰ In addition, we agree with Motorola that the potential for interference to EESS is sufficiently low such that the need for additional study does not warrant a delay in our decision.⁸¹ We find that the high-gain antennas with very narrow beamwidths employed by 60 GHz devices operating under the new higher EIRP limits, combined with the atmospheric attenuation and severe propagation losses at these frequencies will limit any potential for interference to EESS and that sharing of this service with 60 GHz devices at higher EIRP limits will not be a cause for concern.

B. Antenna Substitution

30. Section 15.204(c)(4) of the rules allows intentional radiators to be marketed and used with any antenna that is of the same type and of equal or less directional gain as the antenna authorized with the equipment.⁸² Manufacturers must provide a list of acceptable antenna types with an application for equipment authorization, and the Commission does not require retesting of a system configuration that uses an antenna that is the same type and with equal or less directional gain than the one it authorizes.

31. In the *NPRM*, the Commission noted that intentional radiators must be designed to ensure that the public is not exposed to RF energy in excess of the Commission's guidelines, and that, in some cases this could require that 60 GHz devices operate at a lower emission level than the maximum limit specified in the rules.⁸³ The Commission also observed that the RF exposure levels in the near field and on the antenna surface may increase as the size of the antenna decreases, and the use of a lower gain antenna could result in a transmission system that is more likely to exceed the RF exposure guidelines.⁸⁴ In the *NPRM*, we proposed that the maximum EIRP decrease as the antenna gain is reduced below 51 dBi. For these reasons, the Commission proposed to specify that the provisions contained in Section 15.204(c) of the rules permitting antenna substitutions are not applicable to 60 GHz transmission systems operating under the higher EIRP limits. Rather, the Commission proposed that 60 GHz transmission systems operating under the higher EIRP limits should be marketed and used only with the specific model antenna(s) with which the transmitter is certified.⁸⁵

32. *Comments.* No party objected to our proposal. Motorola supports the use of specific antennas with a specific range in gain and states that allowing users to substitute antennas with higher gain could render the systems non-compliant with the higher EIRP limits.⁸⁶

⁸⁰ See <http://www.fcc.gov/oet/ea/>.

⁸¹ Motorola reply comments at p. 4.

⁸² 47 C.F.R. § 15.204(c)(4). The rule defines "antenna type" as antennas that have the similar in-band and out-of-band radiation patterns.

⁸³ *NPRM*, 22 FCC Rcd. 10505, 10511-10512 (2007) at para. 16. See also, 47 C.F.R. § 1.1301 *et seq.*

⁸⁴ When well matched to body tissues impedance, a small antenna has the tendency to produce a denser "hot spot" (where energy is concentrated) than a larger antenna that covers a larger volume or exposure region where the energy is spread out. In near-field exposure conditions where the antenna is in close proximity to persons, energy coupling and impedance matching typically play a major role in the level of exposure. *NPRM*, 22 FCC Rcd. 10505, 10511-10512 (2007) at para. 16.

⁸⁵ *NPRM*, 22 FCC Rcd. 10505, 10511-10512 (2007) at para. 16.

⁸⁶ Motorola reply comments at p. 4.

33. *Decision.* We conclude that 60 GHz devices that will operate outdoors under the higher EIRP limits we are adopting herein should be authorized for operation using only the specific antenna(s) with which the system will be marketed and operated. In particular, as proposed in the *NPRM*, we will require that compliance testing be performed using the highest gain and the lowest gain antennas for which certification is being sought, rather than testing only the highest gain antenna for each antenna type as permitted by Section 15.204(c). We find that testing of both highest and lowest gain antennas is necessary given that our rules will allow the EIRP to vary relative to the antenna gain, thus ensuring compliance with our emission and RF exposure limits. We will continue to require, as also proposed in the *NPRM*, that compliance testing be performed with the 60 GHz intentional radiator operated at its maximum available output power level and that the applicant for equipment certification provides a list of acceptable antennas with its application. Accordingly, we are amending Section 15.255(b)(1)(ii) to specify the above antenna requirements for the higher power 60 GHz transmitters. Because 60 GHz devices are already required to be tested for compliance with all the types of antennas that are intended to be used with the equipment and to submit the worst-case results in the application for certification, the additional regulatory cost of providing information on an additional test result already required to be performed by our rules is not significant.

C. Spurious Emissions

34. Spurious emissions are those emissions on a frequency outside the necessary bandwidth, the level of which may be reduced without affecting the transmission of information. Section 15.255(c)(3) requires that 60 GHz equipment spurious emissions between 40 GHz and 200 GHz be limited to 90 pW/cm² at a distance of 3 meters, which is equivalent to an EIRP level of -10 dBm.⁸⁷ In the *NPRM*, the Commission proposed to retain the existing limits on spurious emissions but clarified in the proposed rule Section 15.255(c)(3) that measurements must be made in the far field and that if the far field distance is greater than 3 meters, then the measurement results would need to be extrapolated to a distance of 3 meters according to Section 15.31(f)(1).⁸⁸

35. *Comments and Replies.* BridgeWave expresses concerns that in proposing new language for rule Section 15.255(c)(3), we are specifying an extrapolation distance not currently spelled out in this particular rule⁸⁹ and that this change could create hardship in terms of higher cost for expensive filtering circuits when measurement is made in the far field.⁹⁰ BridgeWave believes that application of the extrapolation method in Section 15.31(f)(1) to high-gain 60 GHz antennas effectively reduces spurious emissions to a level *below* what Section 15.255(c)(3) permits today.⁹¹ BridgeWave contends that if

⁸⁷ Spurious emissions from 60 GHz devices are required to comply with the general limits in Section 15.209 for frequencies below 40 GHz and with a limit of 90 pW/cm² (*i.e.*, -10 dBm EIRP) at a distance of 3 meters, between 40 GHz and 200 GHz. 47 C.F.R. §§ 15.209 & 15.255(c)(3).

⁸⁸ *NPRM*, 22 FCC Rcd. 10505, 10509 (2007) at para. 10. *See also*, 47 C.F.R. § 15.31(f)(1). The extrapolation factor is used to address the difficulty of making measurements at specified distances. “Decade”, a 10:1 range, refers to the ratio of the specified measurement distance to the actual measurement distance. 47 C.F.R. § 15.31 (f)(1) requires that “at frequencies at or above 30 MHz, ... [w]hen performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade”. For example, the spurious emission limit for 60 GHz equipment is specified as 90 pW/cm² at 3 meters; if actual measurements were made at a distance of 30 meters based on the particular antenna used, the ratio of the distances is a decade (30/3=10) and as required by the rules, the field strength result must be corrected by adding 20 dB.

⁸⁹ The existing rule only specifies the radiated emission limit for spurious emissions, but does not specify where to measure or what to do if the measurement distance is not at the specified distance of 3 meters.

⁹⁰ BridgeWave reply comments at p. 3-4.

⁹¹ This presumably stems from the fact that since the antenna gain within the near field is less than the far-field value, extrapolating the values obtained from far-field measurements would result in a predicted EIRP level at 3 meters (a distance that would be in the near field of very high gain antennas) that will be greater than what will

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forced to comply with out-of-band emission requirements tighter than what the Commission currently permits under Section 15.255(c)(3), 60 GHz equipment manufacturers may need to incorporate more expensive filters, and that this could increase the costs of manufacturing materials by as much as 15%, thus substantially undercutting the unlicensed 60 GHz band's value proposition as a resource for low cost alternatives to incumbent wired services or more costly E-Band 70/80/90 GHz transceiver systems.⁹² To avoid having to incorporate expensive filters, BridgeWave suggests that we amend section 15.255(c)(3) of the rules to relax the limits for spurious emissions that fall within the 500-megahertz frequency bands immediately below and above the 57-64 GHz band (*i.e.*, the 56.5-57 GHz and the 64.0-64.5 GHz bands) to ten times higher than for the rest of the 40-200 GHz band, over which the spurious emission limit is specified. BridgeWave argues that these sub-bands are subject to the same oxygen attenuation phenomenon as the 60 GHz band generally.⁹³ No other commenter provided substantive input on this issue.

36. On the other hand, the National Radio Astronomy Observatory (NRAO) recommends that we extend the spurious emission limits to additional frequencies. It states that in the time since the Commission first allowed unlicensed operation in the 57-64 GHz band, the radio astronomy service (RAS) has been granted primary allocations at higher frequencies which overlap the low-order harmonics⁹⁴ of portions of the 57-64 GHz band, and that the affected radio astronomy bands contain the two most accessible spectral lines of carbon monoxide at 115 GHz and 230 GHz.⁹⁵ NRAO argues that unlike fundamental frequencies within the 57-64 GHz band, radio astronomy can be adversely affected because spurious emissions propagate relatively free of attenuation by the atmosphere around a radio astronomy site.⁹⁶ It recommends that we extend the limit on spurious emissions up to 232 GHz from 200 GHz to protect radio astronomy bands at 226-231.5 GHz (from the 4th harmonic of fundamental frequencies at 56.5-57.88 GHz. It also recommends as other remedies that we protect the 115 GHz and 230 GHz RAS bands by excluding the entire 57-58 GHz frequency band from use by Part 15 devices, and the 183 GHz RAS band by excluding Part 15 operations near radio astronomy sites located at CARMA (CA), Mt. Graham (AZ) and Mauna Kea (HI).⁹⁷ In response, BridgeWave stated that it does not oppose NRAO's recommendation. No other commenter provided substantive input on this issue.

37. *Decision.* We decline to adopt the clarification proposed in the *NPRM* with regard to the measurement distance with respect to spurious emissions. In the *NPRM*, we proposed to express this limit alternatively as EIRP to be consistent with the measurement unit proposed for main-beam

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actually be realized because there is no allowance for applying a near-field correction factor, which can be different than 20 dB/decade, to the results. However, near-field correction factors are extremely difficult to determine with precision due to the characteristics of the field in this region of the antenna.

⁹² BridgeWave reply comments at p. 4-5. See *Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands*, in WT Docket No. 02-146, *Report and Order*, 18 FCC Rcd. 23318 (2003). See also 47 C.F.R. § 101.1501 *et seq.*

⁹³ BridgeWave reply comments at p. 4-5.

⁹⁴ Harmonics are component frequencies of a radio frequency signal that are integer multiples of the fundamental frequency.

⁹⁵ A spectral line is electromagnetic radiation given off at a specific frequency by an atom or molecule. Each type of atom or molecule gives off radiation at its own unique set of frequencies; thus, astronomers can explore the properties of stars, interstellar matter or other celestial bodies containing a particular molecule by tuning a radio telescope to one of its characteristic frequencies.

⁹⁶ NRAO comments at p. 1-2.

⁹⁷ *Id.*, at p. 3.

fundamental emissions.⁹⁸ BridgeWave's comments clearly indicate a presumption that we have somehow proposed to modify the spurious emission limits, which was never intended. We therefore find that it would be less confusing to maintain the existing spurious emission rule with the limit expressed in power density units, rather than EIRP, and we will make no changes to Section 15.255(c)(3).

38. With respect to BridgeWave's request for an increase in spurious emission limit, we note that we are not making any changes to the spurious emission limit. Thus, we find that the concerns expressed by BridgeWave about increased filtering requirements are not warranted, and likewise there is no reason for us to consider increasing the spurious emission limits as BridgeWave suggests.

39. With regard to the radio astronomy service and NRAO's concerns, we observe at the outset that, although the *NPRM* proposed to increase the average EIRP power limit, we proposed to limit peak emission levels, and also "to retain the existing limits on spurious emissions and peak transmitter output power."⁹⁹ Our intention here was to seek comment on a proposal to maintain the appropriate power limit itself (*i.e.*, in the case of spurious emissions, the existing 90 pW/cm² limit), not on whether to extend that limit to additional frequency bands or to limit the frequency range of operations for 60 GHz devices. Thus, we do not believe it is appropriate to take either of these actions here. In any event, however, we note that because we have not increased the spurious emission limit or reduced the frequency range of measurements (presently 200 GHz) for 60 GHz devices, there is no higher risk of interference from spurious emissions than that which is presently allowed.¹⁰⁰ Moreover, spurious and harmonic emissions typically roll off (*i.e.*, reduce in amplitude) the further they are in frequency from the fundamental emission. Thus, harmonic emissions at the fourth harmonic – produced by the fundamental frequencies at 56.5-57.88 GHz and arising in the RAS band at 226-231.5 GHz - would be expected to be significantly lower than those already deemed to be acceptable at the third harmonic of these fundamental frequencies which are constrained by the present measurement cutoff. Similarly, spurious emissions generated by these devices at the 226-231.5 GHz frequencies in the RAS band would not be expected to be greater than those below 200 GHz (the top of the specified range). Further, while there is considerable difference in the atmospheric attenuation between 60 GHz and 231.5 GHz as claimed by NRAO, the difference in atmospheric attenuation between 200 GHz and 231.5 GHz is not significant and thus would not affect our conclusion. In fact, nearly all of the RAS allocations for which NRAO expresses concern were made before the implementation of unlicensed devices in Section 15.255 of our rules,¹⁰¹ and unlicensed 60 GHz devices have been successfully sharing spectrum with RAS without causing harmful interference.¹⁰² Further, NRAO provides no information or specific analysis of potential harmful

⁹⁸ *NPRM*, 22 FCC Rcd. 10505, 10519 (2007) at Appendix B.

⁹⁹ *NPRM*, 22 FCC Rcd. 10505, 10509 (2007) at ¶10.

¹⁰⁰ 47 C.F.R. § 15.33(a)(3).

¹⁰¹ 47 C.F.R. § 15.255.

¹⁰² On December 19, 2000, the Commission adopted a Report and Order in ET Docket No. 99-261, wherein it made the entire 57-64 GHz band available for use by Part 15 unlicensed devices. *See Amendment of Part 2 of the Commission's Rules to Allocate Additional Spectrum to the Inter-Satellite, Fixed, and Mobile Services and to Permit Unlicensed Devices to Use Certain Segments in the 50.2-50.4 GHz and 51.4-71.0 GHz Bands, Report and Order*, ET Docket No. 99-261, 15 FCC Rcd. 25264 (2000). On February 4, 2004, the Commission adopted the Above 71 GHz Report and Order, wherein it realigned the bands above 71 GHz in order to place scientific services (such as RAS) in spectrum better suited to their needs. *See In the Matter of Amendment of Part 2 of the Commission's Rules to Realign the 76-81 GHz band and the Frequency Range Above 95 GHz Consistent with International Allocation Changes and Amendment of Part 2 of the Commission's Rules to Allocate Additional Spectrum to the Inter-Satellite, Fixed, and Mobile Services and to Permit Unlicensed Devices to Use Certain Segments in the 50.2-50.4 GHz and 51.4-71.0 GHz Bands, Report and Order*, ET Docket Nos. 99-261 and 03-102, 19 FCC Rcd. 3212 (2004). This Report and Order added the RAS allocation to the 231-231.5 GHz band. The remaining RAS allocations indicated by NRAO (*i.e.*, the 111.8-114.25, 114.25-116, 182-185, and 226-231 GHz bands) were made prior to the addition of unlicensed operation in the 57-64 GHz band.

interference from 60 GHz devices to radio astronomy service.

40. Consistent with this experience, we find that interference to RAS stations is unlikely. First, RAS receivers discriminate against off-axis signals. Second, such receivers are typically located in rural areas, not the urban areas where outdoor point-to-point 60 GHz devices are likely to be found. Third, the severe propagation losses of RF signals in the 60 GHz band due to oxygen absorption and atmospheric conditions,¹⁰³ and the highly focused and directional emissions of 60 GHz devices limit any potential for interference from fundamental emissions to RAS such that we do not believe that sharing of this service with 60 GHz devices at higher EIRP levels is a cause for concern. We also do not find that the effect of harmonic and other spurious emissions from 60 GHz devices warrants an extension of the upper frequency band placed on spurious emissions of 60 GHz devices, because as we discussed above, the difference in atmospheric attenuation between 200 GHz and 231.5 GHz is not significant enough to affect the acceptable level of emissions from both spurious and harmonic emissions ensured by operation of our existing rules. In addition, as noted above, we find that NRAO's request to exclude Part 15 operations from the entire 57-58 GHz band is outside of the scope of this proceeding. As for NRAO's request for a geographical separation zone around specific RAS sites, we note that in permitting the 57-64 GHz band to be used for unlicensed operations, the Commission already took into account the 182-185 GHz RAS band, when it adopted the present spurious emission limit, and we are keeping this limit the same, even though we are allowing higher fundamental emission limits, thereby providing the same protection to RAS frequencies as if the fundamental levels are unchanged from existing rules.¹⁰⁴ We therefore deny NRAO's request.

D. Transmitter ID

41. Section 15.255(i) of the rules requires that 60 GHz unlicensed emissions that emanate inside a building include a transmitter ID in order to permit users experiencing interference from indoor wireless local area network (LAN) devices to more accurately identify the source of the interference; this transmitter ID must indicate the manufacturer and type of each unit of equipment.¹⁰⁵ This requirement does not apply to devices with transmitting antennas located outdoors.¹⁰⁶ In the *NPRM*, the Commission proposed to eliminate the transmitter ID requirement for any indoor devices whose emissions are directed outdoors, *e.g.*, through a window.¹⁰⁷ The Commission stated that any interference potential likely will be localized around a window link, and it is more likely that any 60 GHz emissions that are reflected from the glass in a window link will be attenuated by the walls and other surrounding objects and will not impact operations in adjacent areas. The Commission also sought comment on whether the transmitter ID requirement should be eliminated for all 60 GHz systems, as the proximity of indoor co-located

¹⁰³ Free space path loss (FSPL) for a 60 GHz signal is 77.56 dB and for a 230 GHz signal is 89.22 dB at 3 meters from the transmitter (*i.e.*, $FSPL \text{ (in dB)} = 20 \log F + 20 \log d - 147.55$, where F is the signal frequency in Hertz and d is the distance from the transmitter in meter).

¹⁰⁴ See *First R&O/Second NPRM in ET Docket No. 94-124*, 11 FCC Rcd. 4481, 4502 (1995) at para. 48.

¹⁰⁵ The Commission adopted the transmitter identification requirement based on a spectrum etiquette submitted by the Millimeter Wave Communications Working Group (MWCWG), to which there was no objection. See *Amendment Of Parts 2, 15 And 97 Of The Commission's Rules To Permit Use Of Radio Frequencies Above 40 GHz For New Radio Applications, Third Report and Order*, ET Docket No. 94-124, 13 FCC Rcd. 15074, 15075 (1998) at para. 11. See also, 47 C.F.R. § 15.255(i).

¹⁰⁶ See *Report and Order* in ET Docket 99-261, 15 FCC Rcd. 25264, 25281 (2000) at para. 41. The Commission stated that the victim of interference from outdoor equipment would not be able to determine the identity of the manufacturer in order to get its instructions on how to detect and decode its transmitter ID, and thus, the victim could not decode the transmitter ID without first identifying the manufacturer. The Commission also noted that with outdoor point-to-point systems, the need to identify and decode the transmitter ID is unlikely to be a problem. *Id.*

¹⁰⁷ *NPRM*, 22 FCC Rcd. 10505, 10513 (2007), at para. 19.

equipment should allow the user to identify the interfering transmitter to other indoor devices without having to use this feature.¹⁰⁸

42. *Comments.* BridgeWave strongly supports the proposal, stating that window applications are quite rare because office buildings occupants rarely tolerate indoor mounting of a radio behind a window.¹⁰⁹ Motorola further recommends eliminating this requirement for all 60 GHz devices, stating that this requirement imposes unnecessary equipment costs, and should be eliminated to enable the development of lower cost indoor transceivers.¹¹⁰ No party objected to the proposal, although Cisco is concerned about future co-existence between the high-power EIRP devices and low-power WPAN products and notes that the elimination of this requirement may make co-existence more difficult.¹¹¹

43. *Decision.* We are modifying the rules to eliminate the transmitter ID requirement for all 60 GHz devices. Cisco has urged the Commission to consider the work of multiple standards bodies in its deliberations.¹¹² We observe that since the release of the *NPRM*, industry standards have been adopted for indoor 60 GHz WPAN devices which provide more efficient and cost-effective interference avoidance techniques, such as channelization, carrier sense multiple access with collision avoidance (CSMA/CA), beacon frames, etc. These techniques are similar to those implemented by wireless networking products operating in the crowded region of 2.4 GHz or 5.8 GHz frequencies where WPAN devices must co-exist with other WPAN devices as well.¹¹³ We find that, with these technological advances, co-existence between these 60 GHz devices is better resolved by voluntary standards than by a transmitter identification requirement.¹¹⁴ Except for Cisco's concern (which also reflects questions about higher power indoor devices that we have declined to permit), the record in this proceeding provides no support for retaining this requirement. As discussed above, our decision to limit higher power EIRP transmitters to outdoor applications and the factors in our assessment of the interference potential from window links above should alleviate Cisco's and the WPAN industry's concerns, while elimination of the transmitter ID requirement for all 60 GHz devices will lower costs for all 60 GHz devices, including WPAN devices.¹¹⁵ We therefore find that it is unnecessary to maintain a requirement that can add costs to equipment design and installation without any demonstrated countervailing benefit. Accordingly, we are amending our rules to eliminate the transmitter ID requirements for all 60 GHz devices.

IV. PROCEDURAL MATTERS

44. *Final Regulatory Flexibility Analysis.* As required by the Regulatory Flexibility Act, 5 U.S.C. § 603, the Commission has prepared a Final Regulatory Flexibility Analysis (FRFA) of the possible significant economic impact on small entities. The FRFA is set forth in Appendix A.

45. *Paperwork Reduction Act.* This document contains a non-substantial modification to existing information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13. In addition, therefore, it does not contain any new or modified "information collection burden for small business concerns with fewer than 25 employees," pursuant to the Small

¹⁰⁸ *Id.*, at para. 20.

¹⁰⁹ BridgeWave supplemental comments filed on April 9, 2010, at p. 3.

¹¹⁰ Motorola reply comments at p. 2.

¹¹¹ Cisco comments at fn. 1.

¹¹² *Id.* at p. 1.

¹¹³ See e.g., IEEE 802.15.3c-2009 *Wireless MAC and PHY specifications for High Rate WPANs*.

¹¹⁴ *Id.*

¹¹⁵ Outdoor 60 GHz devices are not required to incorporate a transmitter ID. 47 C.F.R. § 15.255(i).

Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. 3506(c)(4).

46. *Congressional Review Act.* The Commission will send a copy of this Report and Order in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. 801(a)(1)(A).

V. ORDERING CLAUSES

47. Accordingly, IT IS ORDERED that pursuant to the authority contained in Sections 4(i), 301, 302, 303(e) and 303(f) of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 301, 302a, 303(e) and 303(f), this Report and Order is hereby ADOPTED and Part 15 of the Commission's Rules ARE AMENDED as set forth in Appendix C, effective **[30 days after date of publication in the Federal Register]**.

48. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Report and Order, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

Appendix A

Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act (RFA),¹ an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Notice of Proposed Rulemaking (NPRM)* in ET Docket No. 07-113.² The Commission sought written public comment on the proposals in the *NPRM*, including comment on the IRFA. This present Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.

A. Need for, and Objectives of, the Report and Order.

2. The Report and Order amends the regulations for outdoor 60 GHz radio frequency devices that do not require a license to permit an increase in the allowable emitted signal level for systems using very high gain directional antennas; to allow the emissions from all 60 GHz systems to be measured as an equivalent isotropically radiated power (EIRP); and to eliminate the need for all 60 GHz systems to emit a transmitter ID signal. The new rules for higher emission limits will promote longer communication ranges for unlicensed outdoor point-to-point 60 GHz broadband digital systems and thereby extend the ability of such systems to supply very high speed broadband service to office buildings and other commercial facilities, promoting broader deployment of point-to-point digital systems in this band. These longer range systems also could have significant benefits for economic development and job growth by providing additional competition in the broadband market and lowering cost for broadband access to small business owners, enabling the operation of communications systems in support of 4th generation (4G) wireless and furthering the Commission's objectives to bring broadband access to every American. In addition, amending the rules to permit the emission limit for any 60 GHz device to be specified as an EIRP conducted power level would promote repeatability of measurement data, facilitating compliance measurements and saving costs for entities making products that must comply with our rules. Further, eliminating the requirement for transmitter identification (transmitter ID) for all 60 GHz equipment would enable the development of lower cost indoor systems in this band. The rule changes in this Report and Order therefore will provide needed flexibility and cost savings for unlicensed devices to support broadband service in the 60 GHz band.

B. Statement of Significant Issues Raised by Public Comments in Response to the IRFA.

3. There were no public comments filed that specifically addressed the rules and policies proposed in the IRFA.

C. Response to Comments by the Chief Counsel for Advocacy of the Small Business Administration.

4. Pursuant to the Small Business Jobs Act of 2010, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration, and to provide a detailed statement of any change made to the proposed rules as a result of those comments. The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

¹ See 5 U.S.C. § 603. The RFA, see 5 U.S.C. § 60-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Public Law No. 104-121, Title II, 110 Stat. 857 (1996), and the Small Business Jobs Act of 2010, Public Law No. 111-240, 124 Stat. 2504 (2010).

² See *In the Matter of Revision of the Commission's Rules Regarding Operation in the 57-64 GHz Band* in ET Docket 07-113, *Notice of Proposed Rulemaking (NPRM)*, 22 FCC Rcd. 10505 (2007).

D. Description and Estimate of the Number of Small Entities to Which the Rules Will Apply.

5. The RFA directs agencies to provide a description of, and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules, if adopted.³ The RFA defines the term “small entity” as having the same meaning as the terms “small business,” “small organization,” and “small business concern” under Section 3 of the Small Business Act.⁴ Under the Small Business Act, a “small business concern” is one that: (1) is independently owned and operated; (2) is not dominant in its field of operations; and (3) meets any additional criteria established by the Small Business Administration (SBA).⁵

6. **Small Businesses, Small Organizations, and Small Governmental Jurisdictions.** Our action may, over time, affect small entities that are not easily categorized at present. We therefore describe here, at the outset, three comprehensive, statutory small entity size standards that encompass entities that could be directly affected by the proposals under consideration.⁶ As of 2009, small businesses represented 99.9% of the 27.5 million businesses in the United States, according to the SBA.⁷ Additionally, a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”⁸ Nationwide, as of 2007, there were approximately 1,621,315 small organizations.⁹ Finally, the term “small governmental jurisdiction” is defined generally as “governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand.”¹⁰ Census Bureau data for 2007 indicate that there were 89,527 governmental jurisdictions in the United States.¹¹ We estimate that, of this total, as many as 88,761 entities may qualify as “small governmental jurisdictions.”¹² Thus, we estimate that most governmental jurisdictions are small.

7. The adopted rules pertain to manufacturers of unlicensed communications devices. The

³ See 5 U.S.C. § 603(b)(3).

⁴ *Id.* § 601(3).

⁵ *Id.* § 632.

⁶ See 5 U.S.C. § 601(3)–(6).

⁷ See SBA, Office of Advocacy, “Frequently Asked Questions,” available at <http://web.sba.gov/faqs/faqindex.cfm?areaID=24> (last visited Aug. 31, 2012).

⁸ 5 U.S.C. § 601(4).

⁹ INDEPENDENT SECTOR, THE NEW NONPROFIT ALMANAC & DESK REFERENCE (2010).

¹⁰ 5 U.S.C. § 601(5).

¹¹ U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES: 2011, Table 427 (2007).

¹² The 2007 U.S. Census data for small governmental organizations are not presented based on the size of the population in each such organization. There were 89,476 local governmental organizations in 2007. If we assume that county, municipal, township, and school district organizations are more likely than larger governmental organizations to have populations of 50,000 or less, the total of these organizations is 52,095. If we make the same population assumption about special districts, specifically that they are likely to have a population of 50,000 or less, and also assume that special districts are different from county, municipal, township, and school districts, in 2007 there were 37,381 such special districts. Therefore, there are a total of 89,476 local government organizations. As a basis of estimating how many of these 89,476 local government organizations were small, in 2011, we note that there were a total of 715 cities and towns (incorporated places and minor civil divisions) with populations over 50,000. CITY AND TOWNS TOTALS: VINTAGE 2011 – U.S. Census Bureau, available at <http://www.census.gov/popest/data/cities/totals/2011/index.html>. If we subtract the 715 cities and towns that meet or exceed the 50,000 population threshold, we conclude that approximately 88,761 are small. U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES 2011, Tables 427, 426 (Data cited therein are from 2007).

appropriate small business size standard is that which the SBA has established for radio and television broadcasting and wireless communications equipment manufacturing. The Census Bureau defines this category as follows: “This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment.”¹³ The SBA has developed a small business size standard for firms in this category, which is: all such firms having 750 or fewer employees.¹⁴ According to Census Bureau data for 2007, there were a total of 939 establishments in this category that operated for part or all of the entire year. Of this total, 784 had less than 500 employees and 155 had more than 100 employees.¹⁵ Thus, under this size standard, the majority of firms can be considered small.

E. Description of Projected Reporting, Record keeping and Other Compliance Requirements.

8. The Report and Order contains a non-substantial modification to the information collection requirements. The rules adopted in this Report and Order will apply to small businesses that choose to use, manufacture, design, import, or sell Part 15 60 GHz devices. There is no requirement, however, for any entity to use, market, or produce these types of products. Small businesses are already subject to the existing rules with regard to reporting, record keeping and other compliance requirements related to 60 GHz devices. The rules adopted in this Report and Order do not add substantial additional compliance burden on small businesses.

F. Steps taken to Minimize Significant Economic Impact on Small Entities and Significant Alternatives Considered.

9. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.¹⁶

10. In this Report and Order, we modify our rules for outdoor 60 GHz radio frequency devices that do not require a license to permit an increase in the allowable emitted signal level for systems using very high gain directional antennas; to allow the emissions from all 60 GHz systems to be measured as an equivalent isotropically radiated power (EIRP); and to eliminate the need for all 60 GHz systems to emit a transmitter ID signal. The new rules for higher emission limits will promote longer communication ranges for unlicensed point-to-point 60 GHz broadband digital systems and thereby extend the ability of such systems to supply very high speed broadband service to office buildings and other commercial facilities, promoting broader deployment of point-to-point digital systems in this band. These longer range devices and services could also have significant benefits for economic development and for consumers and businesses by providing additional competition in the broadband market, lowering costs of broadband access to small businesses without increasing the potential for harmful interference. In addition, amending

¹³ U.S. Census Bureau, 2007 NAICS Definitions, “334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing”; <http://www.census.gov/naics/2007/def/ND334220.HTM#N334220>.

¹⁴ 13 C.F.R. § 121.201, NAICS code 334220.

¹⁵ http://factfinder.census.gov/servlet/IBQTable?_bm=y&-fds_name=EC0700A1&-geo_id=&-_skip=300&-ds_name=EC0731SG2&-_lang=en.

¹⁶ 5 U.S.C. § 603(c).

the rules to permit the emission limit for any 60 GHz device to be specified as an EIRP conducted power level would promote repeatability of measurement data, facilitating compliance measurements and saving costs for large and small entities making products that must comply with our rules. Further, the elimination of the transmitter identification requirement would lower cost and benefit small businesses and consumers of all 60 GHz devices, thereby promoting cost savings without imposing additional regulatory burden.

G. Report to Congress.

11. The Commission will send a copy of the Report and Order, including this FRFA, in a report to be sent to Congress pursuant to the Congressional Review Act.¹⁷ In addition, the Commission will send a copy of the Report and Order, including this FRFA, to the Chief Counsel for Advocacy of the SBA. A copy of the Report and Order and FRFA (or summaries thereof) will also be published in the Federal Register.¹⁸

¹⁷ See 5 U.S.C. § 801(a)(1)(A).

¹⁸ See 5 U.S.C. § 604(b).

Appendix B
Parties Submitting Comments

Comments

1. BridgeWave Communications, Inc. (BridgeWave)
2. Cisco Systems, Inc. (Cisco)
3. IEEE 802.18 Radio Technical Advisory Group (IEEE RR-TAG)
4. National Radio Astronomy Observatory (NRAO)
5. Space Frequency Coordination Group (SFCG)
6. Wireless Communications Association International, Inc. (WCA)
7. World Meteorological Organization (WMO)

Reply Comments

1. BridgeWave Communications, Inc. (BridgeWave)
2. Motorola Inc. (Motorola)
3. Wireless Communications Association International, Inc. (WCA)
4. Panasonic Corporation of North America (Panasonic) (*ex parte*)

Appendix C

Final Rule changes

For the reasons discussed in the preamble, the Federal Communications Commission amends 47 C.F.R. parts 2 and 15 as follows:

**PART 2 – FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS;
GENERAL RULES AND REGULATIONS**

1. The authority citation for part 2 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, and 336, unless otherwise noted.

2. Section 2.1033 is amended by revising paragraph (b)(11) to read as follows:

§ 2.1033 Application for certification.

* * * * *

(b) * * *

* * * * *

(11) Applications for certification of transmitters operating within the 59.0-64.0 GHz band under part 15 of this chapter shall also be accompanied by an exhibit demonstrating compliance with the provisions of Section 15.255 (g) of this chapter.

* * * * *

PART 15 - RADIO FREQUENCY DEVICES

3. The authority citation for part 15 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 302a, 303, 304, 307 and 544A.

2. Section 15.204 is amended by revising paragraph (c) to read as follows:

§ 15.204 External radio frequency power amplifiers and antenna modifications.

* * * * *

(c) An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator. An intentional radiator may be authorized with multiple antenna types. Exceptions to the following provisions, if any, are noted in the rule section under which the transmitter operates, *e.g.*, Section 15.255(b)(1)(ii) of this part.

* * * * *

4. Section 15.255 is amended by revising paragraphs (b), (e), (f) and removing paragraph (i) to read as follows:

§ 15.255 Operation within the band 57-64 GHz.

* * * * *

(b) Within the 57-64 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(1) Products other than fixed field disturbance sensors shall comply with one of the following emission limits, as measured during the transmit interval:

(i) Except as indicated in paragraph (ii) below, the average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm.

(ii) For transmitters located outdoors, the average power of any emission shall not exceed 82 dBm minus 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm minus 2 dB for every dB that the antenna gain is less than 51 dBi. The provisions of Sections 15.204(c)(2) and (c)(4) of this part that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in Section 2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.

(2) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-64 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

(3) For fixed field disturbance sensors other than those operating under the provisions of paragraph (b)(2) of this section, the peak transmitter conducted output power shall not exceed -10 dBm and the peak EIRP level shall not exceed 10 dBm.

(4) The peak power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-64 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be calculated based on the measured peak levels, over the actual time period during which transmission occurs. Measurement procedures that have been found to be acceptable to the Commission in accordance with §2.947 of this chapter may be used to demonstrate compliance.

* * * * *

(e) Except as specified below, the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (b) of this section.

(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range

occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

(2) Peak transmitter conducted output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-64 GHz band and that has a video bandwidth of at least 10 MHz. Measurement procedures that have been found to be acceptable to the Commission in accordance with §2.947 of this chapter may be used to demonstrate compliance.

(3) For purposes of demonstrating compliance with this paragraph, corrections to the transmitter conducted output power may be made due to the antenna and circuit loss.

* * * * *

(f) Frequency stability. Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

* * * * *

**STATEMENT OF
ACTING CHAIRWOMAN MIGNON L. CLYBURN**

Re: *Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band*, ET Docket No. 07-113 and RM-11104

For years, the Commission has championed the concept of opening higher spectrum bands to encourage the development of new products and services. Spectrum above 1 GHz, which was once thought to be inappropriate for consumer products, now supports many innovative devices on an unlicensed basis, such as Wi-Fi, Bluetooth, cordless phones, and even baby monitors. Roughly fifteen years ago, the Commission opened spectrum in the 57-64 GHz band, for the development of unlicensed, short-range devices. Those seeds that were planted, over a decade ago, are just now beginning to blossom with the introduction of Wi-Gig technology that can carry data at gigabit per second speeds over short distances for consumer products.

By making a number of changes to the technical requirements, today's item takes another important step to encourage the technological development in these spectrum bands. For example, increasing the emission limits for outdoor fixed applications will extend the reach of fiber optic networks, and promote broadband backhaul links between cellular base stations.

Tapping into the lightly used upper reaches of the spectrum is an important component in our overall strategy for meeting the high bandwidth demands of tomorrow's networks. It will also help promote expansion of wireless broadband services to rural areas of our country.

Eliminating the requirement for transmitting ID information will promote greater use of wireless-personal-area-networking – or WPAN-- devices. These are the devices that currently allow your personal computer to connect with your HD TV and your Blu-Ray digital video recorders. Today's Order allows manufacturers to reduce administrative costs and invest in greater technological innovation. I am excited to see what future developers will come up with next.

Our Technological Advisory Council has a Working Group on spectrum frontiers that is looking at ways to identify spectrum bands, which have the potential to become the new "beachfronts," and to assess technical or policy changes necessary to enable use of this spectrum. We look forward to receiving those recommendations later this year.

I commend Julie Knapp and his talented staff in the Office of Engineering and Technology for presenting us with another terrific item.

**STATEMENT OF
COMMISSIONER JESSICA ROSENWORCEL**

Re: *Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band*, ET Docket No. 07-113 and RM-11104

With this proceeding, it feels like we go to the galaxy and beyond. We explore the far reaches of our current horizons for spectrum policy. Instead of talking, as we usually do, of spectrum at 5 GHz or below, we set our sights higher. Much higher. We take action in the 60 GHz band.

That is way up there. So what can we use this lofty frequency for?

As it turns out, some really neat things.

First, the 60 GHz band can be used outdoors to send unlicensed signals from one building to the next. That means new ways of extending the reach of fiber optic networks from buildings that are connected to those that are not, without the crushing time and expense of trenching and construction. So to help facilitate these opportunities, we increase outdoor power limits and improve our metrics for measuring interference.

Second, the 60 GHz band can be used indoors to form wide bandwidth channels for a new Wi-Fi standard called 802.11ad. This new standard can lead to the development of small personal networks, ideal for streaming high-definition videos to multiple devices in the same room. That means when you bring up something on your laptop and yearn to see it on a big screen or share it with others nearby, you can instantaneously port it to your television set. But that is only one neat way to use this technology; because there is endless cool that can come with your own personal wireless network.

While we are at it, let's go beyond the potential in the Wi-Fi standard at issue here—802.11ad—and talk about another Wi-Fi technology—802.11ac. Admittedly, this sounds like techno babble. It reads like a jumble of numbers and letters that only an engineer could love. But we should all have affection for the power of Wi-Fi and the possibilities these two standards could unleash. The former, 802.11ad, uses the 60 GHz band to provide unlicensed services across a room. The latter, 802.11ac, uses the 5 GHz band to enable unlicensed networks across a city. Together they can pack a powerful punch.

It was six months ago when the Commission began its proceeding on 5 GHz, noting the possibilities for unlicensed spectrum in the 5.150-5.250 GHz band and the potential for use with the 802.11ac standard. Fast forward. On July 17 of last month, our federal colleagues wrote an important letter regarding ongoing efforts to make the 1755-1780 MHz band available for auction in the near term. But in some ways, this letter buried the lede. Because in it, they noted that they do not need access to this portion of the 5 GHz band for telemetry, leaving it available for Wi-Fi consideration.

We should go beyond our efforts in the 60 GHz band here and also seize this opportunity. We can take the flexible rules that have been the script for an unlicensed success story in the 5.725-5.825 GHz band and expand them to this lower portion of the 5 GHz band. If we do, the 802.11ac standard is bound to really take off. This will mean more potential for unlicensed in this band—and less congestion on licensed wireless networks.

From the 5 GHz band to the heights of 60 GHz, our unlicensed policies can do a range of good and innovative things. So I hope we can continue to be on the lookout for new ideas for unlicensed services—across multiple spectrum bands.

Thank you to the Office of Engineering and Technology for your terrific work way up there in the 60 GHz band. You are pushing the frontiers of our spectrum policy, and with the sky no longer the limit, I am proud to support your efforts—including this Report and Order.

**STATEMENT OF
COMMISSIONER AJIT PAI**

Re: *Revision of Part 15 of the Commission's Rules Regarding Operation in the 57-64 GHz Band*, ET Docket No. 07-113 and RM-11104

We spend a lot of time thinking about the best spectrum policy for the 600 MHz band. In fact, we will discuss the 600 MHz band later this morning. But first, we shorten our attention span. Literally—wavelengths at 60 GHz are approximately 100 times shorter than the wavelengths found in the broadcast spectrum. This is extremely high-frequency spectrum. It's so high that it didn't even make it onto the list of so-called "junk" bands that the Commission made available for unlicensed use in the 1980s.

However, to borrow the title of a 1985 film starring Emilio Estevez, "That Was Then, This Is Now." Currently, one of the biggest challenges we face at the Commission is harnessing enough spectrum to accommodate the growing demand for mobile broadband services. The 60 GHz band can play an important role in meeting this challenge. The signals' short-range propagation and inability to penetrate walls allows for heavy reuse of the spectrum in dense urban areas without causing interference. And critically, the channels are wide; we have previously allocated an enormous 7 GHz of spectrum for unlicensed use. This large, contiguous swath of spectrum between 57–64 GHz could enable high data throughput—precisely what is needed for advanced wireless applications.

This is why I enthusiastically support today's order. It modernizes the Part 15 unlicensed rules that govern the 60 GHz band, which were established about a decade before we fully understood the potential for these frequencies. It allows a sensible increase in power levels, eliminates the obsolete mandate that devices transmit identification information, and streamlines other rules. In sum, it makes using 60 GHz spectrum easier and less expensive.

So what will it be used for? We're still in the early stages of development, but the 60 GHz band holds promise for meeting the needs of consumers who increasingly use high-bandwidth applications. Already, the new 60 GHz IEEE 802.11ad standard (known as WiGig) will enable consumers to stream uncompressed high definition video from a DVD player, a tablet, or a personal computer to a television in the same room without relying on a wired connection. Other applications are limited only by the imagination: point-to-point backhaul, machine-to-machine communications, the list goes on. Both as a Commissioner and as a consumer, I'm excited to see the innovation that these reforms will spur in the years to come.

I commend Chairwoman Clyburn for her leadership and thank the Office of Engineering Technology for its thoughtful treatment of the issues in this rulemaking. The prospect of a world gone wireless makes it crucial that the Commission establish a forward-thinking, flexible spectrum policy. Today's order is an example of the agency doing just that.